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FARM-LEVEL IMPACT ANALYSIS OF THE ADOPTION OF THE PACKAGE OF TECHNOLOGIES INTRODUCED UNDER THE SOYBEAN YIELD GAP ANALYSIS PROJECT (SYGAP)

Abstrak

Studi ini menganalisis dampak adopsi teknologi SYGAP di tingkat petani di Karawang dan Jombang. Umumnya hasil kedelai potensial tidak tercapai oleh petani peserta SYGAP di Karawang dan Jombang. Di Karawang, hasil rata-rata yang dicapai petani peserta SYGAP tidak berbeda nyata dengan bukan peserta SYGAP. Hal ini disebabkan oleh serangan hama ulat pada lahan petani. Sedangkan petani kooperator di Jombang memperoleh hasil lebih tinggi daripada petani non-kooperator. Usaha tani kedelai masih menguntungkan kedua kelompok petani tersebut. Walaupun demikian secara umum peserta SYGAP tidak memperoleh keuntungan lebih tinggi daripada bukan peserta. Adopsi teknologi SYGAP sangat riskan karena variabilitas pendapatan yang relatif tinggi. Disarankan untuk mengembangkan varietas kedelai yang tahan serangan hama dan kekeringan sebelum mempromosikan teknologi SYGAP di daerah yang lingkungannya kurang sesuai.

INTRODUCTION

Background of the Problem

The government paid most attention to soybeans among the secondary crops because of its important role in the economy. Soybean is an important raw material for some food processing industries such as tofu, tempeh, and soy sauce. It is also an important raw material in the feed industries (AARD, 1987).

Soybean is also an important crop in the Indonesian government's diversification program. Large amounts of soybean are imported annually by the Indonesian government owing to the increasing domestic demand for soybeans.

Several measures were undertaken by the Indonesian government to satisfy the increasing domestic demand for soybeans. In the short run, the government imported this commodity mainly from the United States of America and the People's Republic of China. In the long run, the government implemented extensification and intensification programs to increase the national soybean production.

Both the intensification and the extensification programs were conceived to increase the production of soybeans. Soybean production increased from 523,000 mt in 1977 to 1,555,000 mt in 1990 or at an average annual growth rate of 9.4 percent. In the

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same period, soybean area expanded from 646,000 hectares to 1,368 million hectares (6.7 %/year), and soybean yield rose from 0.81 mt/ha to 1.12 mt/ha or at an average annual growth rate of 2.6 percent. Hence, soybean production growth during the 1977-1990 period could be attributed mainly to area expansion rather than to yield improvement. Despite the increase in soybean production, importation of this commodity tended to rise annually due to expanding domestic demand for soybeans. The consumption per capita of soybean increased from 4.56 kg in 1977 to 11.03 kg in 1990 (BPS, 1992; ESCAP CGPRT, 1992; Sudaryanto, 1992; and The CGPRT Centre, 1990).

In 1991, the government represented by the AARD (Agency for Agricultural Research and Development) in cooperation with The Coarse Grains, Pulses, Roots and Tubers (CGPRT) Center implemented a pilot project called the Soybean Yield Gap Analysis Project (SYGAP) in West Java, Central Java, and East Java. This project was implemented until 1991. The recommended soybean technology introduced under the SYGAP are shown in Appendix Table 1.

Specifically, the farmers participating in SYGAP were encouraged to adopt the technologies introduced through provision of credit in kind (e.g., seeds, fertilizer, pesticides) which was payable after harvest and through extension support. The main objective of SYGAP was to improve soybean yield in these provinces.

Objectives of The Study

The objective of this study was to analyze the effects of the adoption of the package of technologies introduced under the SYGAP on soybean productivity, production cost, income and profit of participating farmers in Karawang and Jombang.

CONCEPTUAL FRAMEWORK

New production technologies are new methods or improved ways of using farm inputs to produce a given crop or crop mixture. New farming technologies can be a main agent for reaching economic development in developing countries (Barlow, Jayasuriya, and Price, 1983). In the case of soybeans, new technologies are introduced to improve yield and thereby increase soybean production. The package of technologies proposed by the SYGAP consisted of improved varieties of feeds, fertilizers, pesticides, and other improved cultural practices.

To encourage the farmers to participate in SYGAP, the project provided credit in kind in order to overcome the capital limitation problem of the farmers. Subsidized agricultural credit is a common policy instrument to expand food production in developing countries. In the Philippines, agricultural credit programs were implemented to boost rice production (Rosegrant and Siamwalla, 1988). In Indonesia, agricultural credit at low

interest rate is used as a tool in disseminating new technologies in the new development areas for food crops (Sumaryanto and Pasandaran, 1991).

Furthermore, the project provided extension support to disseminate the package of technologies. The field staff assisted the farmers on the proper application of inputs (e.g., right kind, quantity, and timing of application). Adoption of these recommended technologies under SYGAP is expected to increase soybean productivity or yield. However, to be fully suitable, technologies must not only improve productivity, but be acceptable and attractive to small-scale farmers and increase the community's overall social welfare.

On the other hand, farm productivity is not only determined by the inputs applied. However, characteristics of farmers and their environment also contribute to farm productivity. These factors are farmers' human capital, technical knowledge, and information contacts. The institutional variables such as tenancy, access to credit, and irrigation water constraints also influence farm productivity (Ali and Byerlee, 1991).

To participate in SYGAP, however, the farmers should be willing to face the risk. Factors outside the farmers' control (e.g., pest attack) could destroy the crop and reduce yield considerably. Attitude toward risk of farmers is also one of the important factors affecting adoption of a new technology. Hey (1979) classified attitude of individuals toward risk into: (1) risk aversion, i.e., the higher the risk, the more individual dislikes it; (2) risk neutrality, it means that the individual is indifferent to risk; (3) risk preference, i.e., the higher the risk, the more the individual likes it.

Besides attitude toward risk, there are other factors which influence individuals to become early adopters. Early adopters were found to be those who had low evaluation costs possibly those who were most educated, were the closest to the information centers, and had the most to gain, i.e., those with the greatest potential scale (Welch, 1970). Furthermore, before adopting a new variable input, farmers should first attain a certain critical level of accumulated information. Hence, larger farmers or those who have better information or more human capital will be early adopters.

RESEARCH METHODOLOGY

Data Collection

The study used survey data gathered during the dry season in 1991 under the research project entitled "Soybean Yield Gap Analysis Project" conducted in three provinces, i.e., West Java, Central Java, and East Java.

Data pertaining only to West Java, i.e., Karawang district, and East Java, i.e., Jombang district, were used in this study. Based on an in-depth survey, data were collected twice a month using a structured questionnaire. The following information were

gathered from the soybean farmers: (a) General farming information, i.e. farm size, farm status,and total agricultural land area, (b) Cultural practices: canal size, methods of cleaning, planting, fertilizer application, and weeding, (c) Household characteristics: household size, age, and educational attainment, (d) Inputs including quantities and prices: seed by variety, fertilizer by type, i.e., nitrogen (N), phosphorus (P_2O_5), and potassium (K_2O), labor input by type (family and hired), and (f) Output: quantity and its farm gate price.

The same types of information were gathered from the SYGAP participating and non-participating farmers.

Sampling Procedure

The selection of participating farmers in SYGAP was conducted in two stages. The first step was done by identifying the distribution of farms by size at the extension unit level. The next step was allocating a number of farmers in each farm size class. The selection was marginally adjusted by the farmers' willingness to participate in SYGAP. In each district, there were 45 SYGAP participating farmers of which 30 farmers were chosen as sample farmers. For comparison purposes, 30 non-participating farmers were selected using stratified random sampling. The basis for stratification was farm size.

ANALYTICAL PROCEDURE

Analytical Tools

The impact study adopted a "with and without" method of analysis. Thus, comparison was made between SYGAP participating and non-participating farmers.

Descriptive Analysis and Comparative Mean Analysis

Descriptive statistics such as means and frequencies were used to describe the characteristics of the sample farmers such as age, educational attainment and tenure of the household head, farm size, family size, area planted to soybeans, yield, fertilizer levels used and pesticides applied by type as well as the total seed utilized by the SYGAP participating and non-participating farmers. In the comparative mean analysis, the t-test of means for selected socio-economic characteristics, soybean yield, labor, fertilizer levels used and seeds utilized was employed to determine if there were significant differences in the mean levels of these variables between the SYGAP participating and non-participating farmers.

The t-test of mean was also employed to determine if there was a significant difference in the mean soybean yield levels between Karawang and Jombang.

T-test of Mean from Hypothesized Value

To determine whether the actual mean yield of the SYGAP participating farmers was significantly different from the potential or targeted yield of SYGAP, the t-test of mean from hypothesized value (e.g., potential yield) was conducted. If the actual mean yield of the SYGAP participants was found to be equal or significantly higher than the targeted yield based on the t-test, then it can be concluded that the SYGAP was successful in attaining its yield objective.

Costs and Returns Analysis

For comparison purposes, all receipts and expenses were computed on a per hectare basis for both the SYGAP participating and the non-participating farmers. The costs and returns analysis employed the following formulas:

$$(1.1)\quad TFR = Y P_y$$
$$(1.2)\quad TC = TVC + TFC$$
$$(1.3)\quad GM = TFR - TVC$$
$$(1.4)\quad NIP = TFR - TC$$

where:

Y	is soybean yield in kg,
P_y	is price of soybean per kg,
TFR	is total farm receipts,
TVC	is total variable cost,
TFC	is total fixed cost,
TC	is total cost,
GM	is gross margin, and
NIP	is net income or profit.

Risk Assessment of SYGAP Technologies

The difference in the mean net profits of the SYGAP participants and the non-participants would not only be the basis for the farmers' decision on whether to continue adopting the SYGAP technologies or not, but also the riskiness of adopting these new technologies *vis a vis* the comparison of the variability in net income between the SYGAP participants and non-participants.

The variance in net profit was computed as follows :

$$(1.5) \quad V = 1/N \sum_{i}^{N} (Xi - \bar{x})$$

where:

$\bar{x}$ is mean net profit,

$X i$ is observed or actual profit,

V is variance, and

i = 1,2, ..., 30.

The variances in net income of both the SYGAP participants and the non-participants were computed and compared.

Moreover, the coefficient of variation (CV) was also computed as follows :

$$(1.6) \quad CV=(V/\bar{x}) \times 100\%$$

The variance decomposition analysis (Glewwe, 1986) was employed to determine which factors have more effect on risk or variability :

$$(1.7) \quad NFI = TR - TC$$

where:

NFI is net farm income,

TR is total revenue, and

TC is total cost.

$$(1.8) \quad V(TR-TC) = V(TR) + V(TC) - 2\,Cov\,(TR,TC)$$

RESULTS AND DISCUSSION

Characteristics of the Soybean Sample Farmers

Table 1 shows that the mean educational attainment, family size, and farm size were not significantly different between the SYGAP participants and the non-SYGAP participants in Karawang. On the average, both the SYGAP participants and the non-SYGAP participants in Jombang had the same family size.

Although the soybean areas operated by both farm groups were small (0.074 ha for SYGAP participants and 0.201 ha for non-SYGAP participants), the mean soybean area operated by the non-SYGAP participants was significantly higher than that operated by the SYGAP participants. The SYGAP participating farmers in this district had significantly higher educational attainment and larger farms, on the average, than the non-SYGAP participants. However, the average soybean area cultivated by the SYGAP participants (0.110 ha.) was significantly smaller than that operated by the non-SYGAP participants (0.406 ha).

Table 1. Selected socio-economic characteristics of SYGAP participating and non-participating farmers, 120 sample farmers, Karawang, West Java and Jombang, East Java, 1991.

LOCATION/ SOCIO-ECONOMIC CHARACTERISTICS	PARTICIPANTS	NON-PARTICIPANTS	DIFFERENCE
KARAWANG, WEST JAVA			
1. Mean age (years)	45	40	5 *
2. Mean educational attainment (years)	3	4	-1 ns
3. Average family size (number of members)	4	4	0 ns
4. Average soybean area operated (ha)	0.074	0.201	-0.127 ***
5. Average farm land assets (ha)	0.453	0.182	0.271 ns
JOMBANG, EAST JAVA			
1. Mean age (years)	39	50	-11 ***
2. Mean educational attainment (years)	7	4	3 ***
3. Average family size (number of members)	5	5	0 ns
4. Average soybean area operated (ha)	0.110	0.406	-0.296 ***
5. Average farm land assets (ha)	1.121	0.640	0.481 ***

Note : ***, **, * mean significantly different at 1%, 5%, and 10% probability levels, respectively.
ns means significantly different at 10% probability leve

With regard to the existing tenurial forms in Karawang, the majority (74%) of the 30 SYGAP participants were borrower-operators (Table 2). Similarly, the borrower-operators predominated (70%) among the non-SYGAP participants, followed by the owner-operators (20%). In Jombang, the owner-cultivators predominated in both farm groups (e.g., 90 % for the SYGAP participants and 80 % for the non-SYGAP participants) (Table 2).

Table 2. Tenure status of SYGAP participating and non-SYGAP participating farmers, 120 sample respondents, Karawang, West Java, and Jombang, East Java, 1991.

DISTRICT/ TENURE STATUS	SYGAP PARTICIPANTS		NON-SYGAP PARTICIPANTS	
	Number of Farmers Reporting	Percent	Number of Farmers Reporting	Percent
KARAWANG, WEST JAVA				
Owner operator	4	13	6	20
Lessee	3	10	1	4
Borrower-operator	22	74	21	70
Mortgaged land operator	0	0	1	3
Government land operator	1	3	1	3
Total	30	100	30	100
JOMBANG, EAST JAVA				
Owner-operator	27	90	24	80
Share-tenant	1	3	2	7
Lessee	2	7	2	7
Government land operator	0	0	2	6
Total	30	100	30	100

EMPIRICAL RESULTS OF THE FARM LEVEL IMPACT ANALYSIS

Adoption of the Recommended Package of Technologies Karawang, West Java

Seed variety and seeding rate. The recommended soybean varieties in Karawang were NS1 and Galur (Table 3). All the 30 SYGAP farmer-participants adopted the recommended varieties.

Only two of the 30 non-participants (7 %) adopted NS1 which is one of the recommended varieties under SYGAP. The majority (93 %) of the non-participants planted other soybean varieties such as Lokon, Wilis, Kerinci, and Pelita.

The majority of the SYGAP participants (60 %) in this district adopted the required seeding rate of 60 kg/ha (Table 3). It can be noted in Table 4 that the average quantity of soybean seeds used by the SYGAP participants in Karawang (70 kg/ha) was 10 kg/ha higher than the recommended seeding rate. This could be attributed to the fact that six of the 30 SYGAP participants (20 %) replanted because of pest attack (Table 5).

Table 3. Adoption of recommended package of technologies by SYGAP and non-SYGAP participants, 60 sample soybean farmers, Karawang, West Java, 1991.

RECOMMENDED TECHNOLOGIES	PARTICIPANTS		NON-PARTICIPANTS	
	Number	%	Number	%
Number of farmers reporting	30		30	
1. Seed variety				
a. NS_1	8	27	2	7
b. Galur	22	73	0	0
2. Fertilizers				
a. 22.5 kg N	24	80	1	3
b. 34.5 kg P_2O_5	29	97	3	10
c. 25 kg K_2O	24	80	2	7
3. Pest control				
3 sprays	2	7	8	27
4. Seeding rate				
60 kg/ha	18	60	5	17
5. Distance between drainage canals				
Every 4 m	29	97	0	0

Fertilizer application. The recommended fertilizer levels in Karawang were as follows: 22.5 kg/ha of nitrogen, 34.5 kg/ha of phosphorus, and 25 kg/ha of potassium (Table 3). Not all of the SYGAP participants, however, followed the fertilizer recommendations. This could be partly explained by the fact that the fertilizer application of the SYGAP participants was not closely monitored by the project staff. There were only two project personnel in the district, who jointly provided extension service to the participants and also collected input-output data from the SYGAP participants and non-participants.

About 97 percent of the SYGAP participants used the recommended phosphorus level while 80 percent adopted the recommended nitrogen and potassium levels (Table 3). The SYGAP participants applied 28 kg/ha of nitrogen fertilizer which was more than the recommended nitrogen level and 35.2 kg/ha of phosphorus which was also slightly higher than the recommended phosphorus level. However, they applied 24.2 kg/ha of potassium, on the average, which was 0.8 kg/ha lower than the recommended rate. About 80 percent of the SYGAP participants applied fertilizer once while 20 percent applied twice (Table 5). Some SYGAP participants also applied foliar fertilizers. Appli-

cation of those fertilizers was not included in the package of technologies introduced by SYGAP, but some farmers used them because of the promotion campaign given by salesmen employed by fertilizer companies.

With regard to the fertilizer practices of the non-SYGAP participants, only one farmer adopted the recommended nitrogen level, two farmers applied the recommended rate of phosphorus, and three farmers used the recommended potassium rate. It is apparent from Table 4 that the mean level of nitrogen applied by the non-SYGAP participants (65.1 kg/ha) was significantly higher than that applied by the SYGAP participants (28 kg/ha). On the other hand, the mean levels of phosphorus and potassium (21.3 kg/ha and 2.3 kg/ha, respectively) applied by the non-SYGAP participants were significantly lower than those used by the SYGAP participants (35.2 kg/ha and 24.2 kg/ha, respectively). The majority of the non-SYGAP participants (70 %) applied fertilizers twice (Table 5).

Pesticide use. Pest control was carried out by all the SYGAP participants and the non-SYGAP participants indicating the prevalence of pest infestation (e.g., army worms) in Karawang (Table 5). The recommended frequency of pesticide spraying in Karawang is three (3), but only two SYGAP participants (7 %) and 8 non-participants (27 %) followed this recommendation. Owing to serious pest outbreak in Karawang, the majority (93 %) of the SYGAP participants sprayed more than the recommended frequency of spraying, that is, from 4-8 times (Table 5). Similarly, most of the non-SYGAP participants (60 %) sprayed more than three times (4 - 9 times) for the same reason. Only four non-SYGAP participants (13 %) sprayed less than the recommended frequency of pesticide spraying (i.e., 1 - 2 times). On the average, the SYGAP participants sprayed five (5) times as compared to four (4) times for the non-participants (Table 6).

Drainage. The recommended distance between drainage canals is 4 meters. Except for one farmer, almost all of the 30 SYGAP participants (97 %) followed the recommended distance between drainage canals (Table 3). On the other hand, none of the non-SYGAP participants adopted the recommended distance between drainage canals.

The project did not provide any recommendation on the frequency of irrigating the soybean fields. Most of the farmers in both farm groups (63 % of the SYGAP participants and 40 % of the non-SYGAP participants) irrigated the farms they were operating twice.

Jombang, East Java

Seed variety, seeding rate, and seed treatment. All the SYGAP participants and the non-SYGAP participants in Jombang planted the recommended variety, Wilis (Table 7). This variety is very popular among the soybean growers in the district because it is high-yielding and possesses physical and chemical characteristics that make it a good raw material for tofu production (Irawan and Lancon, 1991 and Nugraha, 1992).

Table 4. Inputs applied per hectare by 60 sample soybean farmers, Karawang, West Java, 1991.

INPUT ITEM	UNIT	PARTICI-PANTS	NON-PARTICIPANTS	DIFFERENCE
1. Seed	kg	70	42	28 ***
2. Labor				
a Family	hrs	2185	1319	866
b. Hired	hrs	345	324	21
c. Total	hrs	2530	1643	887 ***
3. Main Fertilizers				
a. Nitrogen	kg	28.0	65.1	-37.1 ***
b. Phosphorus	kg	35.2	21.3	13.9 ***
c. Potassium	kg	24.2	2.3	21.9 ***
4. Foliar Fertilizers				
a. Bayfolan	ml	0	14	-14
b. Gandasil-B	gr	391	0	391
c. PPC	ml	0	129	-129
d. Zn	gr	0	0	0
5. Pesticides				
a. Atagron	ml	57	0	57
b. Azodrin	ml	2002	768	1234
c. Baythroid	ml	0	11	-11
d. Buldok	ml	35	11	24
e. Bultin	ml	13	0	13
f. Cumacron	ml	0	16	-16
g. Decis	ml	325	105	220
h. Dursban	ml	7165	2094	5072
i. Furadan	gr	0	129	-129
j. Hopcin	ml	0	13	-13
k. Karphos	ml	0	270	-270
l. Lannate	ml	29	65	-36
m. Larvin	gr	263	532	-268
n. Matador	ml	26	43	-17
o. Mepcin	gr	100	126	-26
p. Nogos	ml	0	95	-95
q. Pastac	ml	111	63	48
r. Sevin	gr	185	231	-46
s. Sumithion	ml	0	35	-35
t. Tamaron	ml	26	7	19
u. Thiodan	ml	89	66	22
v. Throid	ml	0	7	-7

*** , ** , * are significantly different at 1 %, 5 %, and 10 % probability levels, respectively.
ns is not significantly different at 10% probability level.

Table 5. Comparison of cultural practices between SYGAP participants and non-participants, 120 sample farmers, Karawang, West Java and Jombang, East Java, 1991.

FARM PRACTICE	KARAWANG		JOMBANG	
	Number of Participants Reporting	Number of Non Participants Reporting	Number of Participants Reporting	Number of Non Participants Reporting
Number of sample farmers	30	30	30	30
1. Planting method				
a. Broadcast/put on soil surface	1	8	2	19
b. Dibble	29	22	28	11
2. Replanting				
a. Replant	6	15	7	3
b. No replant	24	15	23	27
3. Fertilizer application method				
a. Broadcast	0	1	23	25
b. Dibble	0	0	1	0
c. Surrounding the crop	2	0	6	5
d. In row	21	0	0	0
e. Mixed with water	7	29	0	0
4. Frequency of fertilizer application				
a. None	0	0	0	1
b. Once	24	2	25	21
c. 2 times	6	21	5	6
d. 3 times	0	7	0	2
5. Weeding method				
a. No weeding	1	2	1	1
b. Thorough weeding	6	6	27	22
c. Light weeding	23	22	2	7
6. Frequency of pesticide spraying				
a. Once	0	1	0	2
b. 2 times	0	3	1	6
c. 3 times	2	8	6	10
d. 4 times	10	5	11	7
e. 5 times	5	7	7	3
f. 6 times	9	4	2	1
g. 7 times	3	1	3	1
h. 8 times	1	0	0	0
i. 9 times	0	1	0	0

Table 5. Continued

FARM PRACTICE	KARAWANG		JOMBANG	
	Number of Participants Reporting	Number of Non Participants Reporting	Number of Participants Reporting	Number of Non Participants Reporting
7. Frequency of irrigating the field				
a. None	2	2	0	0
b. Once	6	9	1	3
c. 2 times	19	12	22	20
d. 3 times	3	5	7	7
e. 4 times	0	2	0	0
8. Distance between drainage canals				
a. No canal	0	6	0	0
b. Every 1 m	0	14	0	0
c. Every 2 m	0	10	0	6
d. Every 3 m	1	0	23	15
e. Every 4 m	29	0	7	6
f. Every 5 m	0	0	0	2
g. Every 6 m	0	0	0	1

Table 6. Comparison of the frequency of pesticide spraying and pesticide cost between the SYGAP participants and the non-participants, 120 sample farmers, Karawang, West Java and Jombang, East Java, 1991.

ITEM	KARAWANG			JOMBANG		
	P	NP	Difference	P	NP	Difference
1. Frequency of pesticide spraying	5	4	1**	4	3	1 ***
2. Pesticide expenditure (Rp/ha)	178140	116047	62093*	92864	30116	62748 ***

Note: P refers to participants; NP refers to non-participants ***, **,* mean significantly different at 1%, 5%, and 10% probability levels, respectively

The recommended seeding rate for Wilis variety is 45 kg/ha. As presented in Table 7, not all of the SYGAP participants in Jombang adopted the recommended seeding rate. Nevertheless, the majority (63 %) of the SYGAP participants in this district followed the recommended seeding rate as compared to only 20 percent for the non-SYGAP participants. On the average, the seeding rates of the SYGAP participants (47 kg/ha.) and the non-SYGAP participants (54 kg/ha.) in Jombang did not differ significantly (Table 8). It is apparent that the mean seeding rates of both the SYGAP

participants and the non-SYGAP participants were slightly higher than the recommendation. This implies that those who did not follow the recommendation used more seeds per hectare. Moreover, the higher seeding rates of both farm groups can be partly attributed to the fact that 23 percent of the SYGAP participants and 10 percent of the non-SYGAP participants replanted due to pest attack (Table 5).

Seed treatment is also recommended prior to planting. As presented in Table 7, most of the SYGAP participants (93 %) in Jombang treated the seeds before planting. None of the non-SYGAP participants, however, practiced seed treatment prior to planting.

Dibbling was the widely used planting method adopted by the SYGAP participants in Jombang (93 %) (Table 5). On the other hand, the most common planting method used by non-SYGAP participants was broadcasting (63 %), followed by dibbling (37 %).

Fertilizer application. Not all of the 30 SYGAP participants followed the fertilizer recommendations (Table 7). A higher proportion of the SYGAP participants in this district followed the recommended phophorus rate (90 %) as compared to those who adopted the recommended nitrogen rate (83 %) and potassium rate (50 %). On the average, the fertilizer rates applied were close to the recommendation (Tables 7 and 8).

Among the 30 non-SYGAP participants in Jombang, only three farmers applied the recommended fertilizer rate and two farmers followed the recommended phosphorus rate despite the fact that they were also using the same variety as the SYGAP participants (Table 7). None of the non-SYGAP participants applied the recommended potassium rate.

Generally, both the SYGAP participants and the non-SYGAP participants in Jombang applied fertilizers once using the broadcasting method (Table 5). Although the application of foliar fertilizers was not recommended by the SYGAP staff, both farm groups used foliar fertilizers.

Pesticide use. The recommended frequency of pesticide spraying in Jombang (5 times) is higher than in Karawang (3 times) (Tables 4 and 7). Very few of the SYGAP participants and the non-SYGAP participants in Jombang adopted the pesticide recommendation. The mean frequency of pesticide spraying of the SYGAP participants (4 times) in this district was lower than the recommended frequency of pesticide spraying. Comparing the frequency of spraying between the SYGAP participants and the non-participants, a larger proportion of the SYGAP participants (23 %) adopted the pest control recommendation compared to the non-SYGAP participants (10%). On the average, the frequency of pesticide spraying of the SYGAP participants (4 times) was significantly higher than that of the non-SYGAP participants (3 times) (Table 6).

Drainage. The recommended distance between drainage canals in Jombang is 3 meters. Even though not all of the SYGAP participants in the district followed the recommended distance between drainage canals, the majority (77 %) adopted the recommendation. On the other hand, 50 percent of the non-SYGAP participants in Jombang adopted the recommended distance in drainage canal construction (Tables 5 and 7).

Table 7. Adoption of recommended package of technologies by SYGAP and non-SYGAP participants, 60 sample soybean farmers, Jombang, East Java, 1991.

RECOMMENDED TECHNOLOGIES	PARTICIPANTS		NON-PARTICIPANTS	
	Number	%	Number	%
Number of farmers reporting	30		30	
1. Seed variety Wilis	30	100	30	100
2. Fertilizers				
a. 22.5 kg N	25	83	3	10
b. 34.5 kg P_2O_5	27	90	2	7
c. 25 kg K_2O	15	50	0	0
3. Pest control 5 sprays	7	23	3	10
4. Seed treatment before planting	28	93	0	0
5. Seed quantity or seeding rate 45 kg/ha	19	63	6	20
6. Distance between drainage canals Every 3 m	23	77	15	50

Table 8. Inputs applied per hectare by 60 farmers in Jombang, 1991.

INPUT ITEM	UNIT	PARTICI-PANTS	NON-PARTICI-PANTS	DIFFERENCE
1. Seed	kg	47	54	-7 ns
2. Labor				
a Family	hr	601	372	229
b. Hired	hr	639	313	326
c. Total	hr	1239	685	887 ***
3. Main Fertilizers				
a. Nitrogen	kg	22.7	19.1	3.5 ns
b. Phosphorus	kg	22.4	8.4	14.1 ***
c. Potassium	kg	24.4	3.7	20.7 ***
4. Foliar Fertilizers				
a. Gandasil	gr	140	101	39
b. Orstan	ml	21	19	2
c. Orstil	ml	0	138	-138
d. PPC	ml	177	0	77
e. Super Orstind	ml	121	167	-46
f Sprint	ml	0	61	-61
g. Superfit	ml	0	18	-18
h. Suprasil	ml	76	19	57
i. ZPT	ml	0	50	-50
5. Pesticides				
a. Azodrin	ml	1324	231	1093
b. Basalt	gr	27	0	37
c. Darmasan	ml	6	18	-13
d. Decis	ml	99	0	99
e. DDT	gr	00	360	-360
f. Dursban	ml	2465	244	2221
g. Elsan	ml	0	102	-102
h. Hopcin	ml	0	68	-68
i. Lannate	gr	12	37	-25
j. Lebasit	ml	150	0	150
k. Marshal	kg	330	0	330
l. Matador	ml	147	273	-126
m. Phosphite	gr	4	0	4
n. Thiodan	ml	314	219	94

***, **, *, mean significantly different at 1 %, 5 %, and 10 % probability levels, respectively.
ns is not significantly different at 10% probability level.

Comparison of Mean Yields Between SYGAP Participants and Non-SYGAP Participants

The mean yield levels of the SYGAP participants (1,078 kg/ha) and the non-SYGAP participants (884 kg/ha) in Karawang were not significantly different. This could be attributed to serious pest outbreak (e.g., army worms) and the variation in the planting schedule of most farmers in Karawang. The frequency of pesticide spraying reflects the degree of pest infestation. Soybean crops of both the SYGAP participants and the non-participants were attacked by pests despite the fact that the majority of the farmers in both farm groups sprayed 3 - 9 times. Considering that the soybean farmers in the district did not plant at the same time, it was difficult to completely eradicate pests in the district. Thus, the yield-augmenting effect of the SYGAP technologies was masked by serious pest infestation in Karawang.

Pest infestation was also prevalent in Jombang but not as serious as in Karawang during the 1991 dry season. As presented in Table 9, the mean soybean yield (971 kg/ha) obtained by the SYGAP participants in Jombang was significantly higher than that of the non-SYGAP participants (719 kg/ha). Considering that there was also an outbreak of pests in Jombang during the 1991 dry season, it was very important that farmers in this district should follow the pest control recommendation to obtain higher soybean yields.

Table 9. Comparative mean yields of 120 sample soybean farmers in Karawang, West Java and Jombang, East Java, Indonesia, 1991

DISTRICT	YIELD (kg/ha)		
	Participants	Non-participants	Difference
Karawang	1,078	884	194 ^{ns}
Jombang	971	719	252 *

***, **, * mean significantly different at 1%, 5%, and 10% probability levels, respectively.
ns means not significantly different at 10% probability level

Comparison Between Actual Farm Yields and the Potential Yield of SYGAP

The potential or target yields in Karawang and Jombang were based on the yields obtained from experiments conducted by CGPRT from 1989 to 1990 when there was no pest infestation in both sites and no drought in Jombang. It can be inferred from Table 10 that the potential or target soybean yields were not generally achieved by SYGAP in both districts. In Karawang district, the mean soybean yield of the SYGAP participants (1078 kg/ha) was significantly lower by 448 kg/ha compared to the target yield of 1526 kg/ha. This could be attributed to the following reasons: (1) not all of the SYGAP

farmer-participants adopted the whole package of recommended technologies; and (2) there was serious pest infestation during the 1991 dry season. Similarly, the mean soybean yield obtained by the SYGAP participants (971 kg/ha) in Jombang was significantly lower than the potential or target yield in this district (1896 kg/ha). This could be explained by: (1) not all of the SYGAP farmer-participants fully adopted the recommended package of technologies; (2) there was pest outbreak in the district although not as serious as in Karawang; and (3) there was drought during the 1991 dry season. The occurrence of drought during the 1991 dry season was the major reason why actual farm yields in Jombang were far below the potential yield.

Table 10. Comparison between actual mean soybean yields and potential soybean yields of SYGAP participants, Karawang, West Java and Jombang, East Java, 1991.

LOCATION	ACTUAL MEAN YIELD (kg/ha)	TARGET/POTENTIAL YIELD (kg/ha)	DIFFERENCE (kg/ha)
Karawang, West Java	1078	1526	-448 ***
Jombang, East Java	971	1896	-925 ***

*** is signifiantly different at 0.01 probability level.

Results of the Costs and Returns Analysis
Karawang, West Java

As shown in Table 11, there was no significant difference in the mean gross income (or total revenue) between the SYGAP participants (Rp 993,621/ha) and the non-participants (Rp 706,062/ha). This might be explained by the fact that mean soybean yields did not significantly vary between these two farm groups. Although the difference in total variable cost was not significantly different between the SYGAP participants and the non-participants, the mean expenditures of the SYGAP participants on production inputs recommended by the project such as seeds, nitrogen, phosphorus, and potassium fertilizers, and pesticides were significantly higher than those incurred by the non-participants. Among the SYGAP participants, the major expenditure items were pesticides (34.5%) due to army worm infestation, labor (31.2 %), and seeds (18.5 %). Fertilizer accounted for 10 percent of the total cost. On the other hand, the largest expenditure item of the non-participants was hired labor accounting for 38.6 percent of the total costs, followed by pesticides (27.4 %), seeds (14.5 %), and fertilizer (12.2 %). High expenditure on pesticides by the non-participants could also be attributed to pest attack on their fields.

Table 11. Results of the costs and returns analysis in soybean production, 60 sample farmers, Karawang, West Java, 1991

ITEM	SYGAP PARTICIPANTS (Rp/ha)		NON-SYGAP PARTICIPANTS (Rp/ha)		DIFFERENCE (Rp/ha)
1. Gross income					
Soybean sales	993621		706062		287560 ^{ns}
Gross income	993621		706062		287560 ^{ns}
2. Variable costs					
Seed	95385	(18.5)	61461	(14.5)	33925 ***
Main fertilizers:					
Nitrogen	14349	(2.8)	34263	(8.1)	-19915 ***
Phosphorus	20901	(4.1)	13518	(3.2)	7383 ***
Potassium	13310	(2.6)	1702	(0.4)	11608 ***
Additional fertilizers	3075	(0.6)	2258	(0.5)	818 ^{ns}
Pesticides	178140	(34.5)	116047	(27.4)	62093 *
Hired labor	160929	(31.2)	163060	(38.6)	-2131 ^{ns}
Interest on variable costs	8864	(1.7)	11255	(2.7)	-2390 ^{ns}
Total variable cost	494953	(95.9)	403564	(95.4)	91389 ^{ns}
3. Fixed costs					
Rent	13300	(2.6)	8867	(2.1)	4433 ^{ns}
Tax	6933	(1.3)	9707	(2.3)	-2773 ^{ns}
Interest on fixed cost	809	(0.2)	743	(0.8)	66 ^{ns}
Total fixed cost	21043	(4.1)	19316	(4.6)	1726 ^{ns}
4. Total cost	515996	(100.0)	422880	(100.0)	93116 ^{ns}
5. Gross margin	498668		302498		196170 ^{ns}
6. Net income before tax	484836		293277		191559 ^{ns}
7. Net income after tax	477625		283182		194444 ^{ns}

Note: ***, **, * mean significantly different at 1%, 5%, and 10% probability levels, respectively.
^{ns} means not significantly different at 10% probability.
Figures in parantheses are percentages.

The mean total fixed cost, total cost, gross margin and net income did not vary significantly between the SYGAP participants and the non-participants in this district (Table 11). Mean net incomes received by the SYGAP participants and the non-participants were not significantly different because mean gross income and total cost did not vary significantly between these two farm groups.

The SYGAP participants obtained a gross margin of Rp 498,668/ha which was not significantly different from Rp 302,498/ha obtained by the non-participants. More-

over, the mean net income after tax received by the SYGAP participants of Rp 477,625/ ha was not signifiantly different from Rp 283,182/ha obtained by the non-participants. Generally, the SYGAP participants in Karawang had no profit advantage over the non-participants.

Jombang, East Java

Table 12 shows that the mean gross income of the SYGAP participants (Rp 775, 680/ha) in Jombang was significantly higher than that of the non-participants (Rp 560, 754/ha) due to higher soybean yields obtained by the former.

Although the SYGAP participants in this district had an income advantage over the non-participants, their total expenditure (Rp 599,000), however, was, on the average, significantly higher than that of the latter (Rp 288,431/ha). This could be attributed to their significantly higher expenditures on hired labor and material inputs recommended under SYGAP such as seeds, phosphorus and potassium fertilizers, pesticides, and hired labor. Hired labor was the largest expenditure item of the SYGAP participants accounting for 52 percent of the total cost, followed by pesticides (15.5 %), and seeds (11.3 %). Similarly, hired labor was also the major expenditure item (48 %) of the non-participants.

On the average, the mean gross margin of the SYGAP participants in Jombang was Rp 237,330/ha compared to Rp 318,695/ha received by the non-participants. SYGAP participants received an average net income after tax of Rp 176,670/ha while the non-participants had Rp 272,322/ha (Table 12).

As presented in Table 12, mean gross margin and net income, however, did not vary significantly between the SYGAP participants and the non-participants. This could be explained by the fact that although the mean gross income of the SYGAP participants was significantly higher than that of the non-participants, their mean total cost was also significantly higher than the latter. Based from these findings, it can be deduced that in general SYGAP farmers in Jombang had no profitability advantage over the non-participants.

Results of the Risk Analysis

Table 13 shows that the coefficients of variation of total cost of SYGAP participants in Karawang and Jombang (42 and 63 percent, respectively) were lower than those of the non-SYGAP participants (84 and 63 percent for Karawang and Jombang, respectively). These figures suggest that the variation in total cost of the SYGAP participants was smaller due to their adoption of the same technologies (i.e., recommended package of technology).

Table 12. Results of the costs and returns analysis in soybean production, Jombang, East Java, 1991.

ITEM	SYGAP PARTICIPANTS (Rp/ha)		NON-SYGAP PARTICIPANTS (Rp/ha)		DIFFERENCE (Rp/ha)
1. Gross income					
- Soybean sold	775680		560754		214926 ***
- Gross income	775680		560754		214926 ***
2. Variable costs					
- Seed	67937	(11.3)	22936	(8.0)	45001 ***
- Main fertilizers:					
Nitrogen	11210	(1.9)	8645	(3.0)	2564 ns
Phosphorus	13251	(2.2)	4981	(1.7)	8270 ***
Potassium	13192	(2.2)	1927	(0.7)	11264 ***
- Additional fertilizers	3071	(0.5)	4233	(1.5)	-11 ns
- Pesticides	92864	(15.5)	30116	(10.4)	62748 ***
- Hired labor	310997	(51.9)	131317	(45.5)	179680 ***
- Lease payment in kind	12656	(2.1)	23236	(8.1)	-10580 ns
- Interest on variable costs	13629	(2.3)	8753	(3.0)	4876 **
Total variable cost	538350	(89.9)	242058	(83.9)	323415 ***
3. Fixed costs					
- Rent	26667	(4.5)	14667	(5.1)	12000 ns
- Tax	31660	(5.3)	30488	(10.3)	1173 ns
- Interest on fixed cost	2333	(0.4)	1220	(0.4)	1114 ns
Total fixed cost	538350	(10.1)	46374	(16.1)	14286 ns
4. Total cost	599010	(100.0)	288431	(100.0)	310578 ***
5. Gross margin	237330		318695		-81366 ns
6. Net income before tax	204403		287575		-83172 ns
7. Net income after tax	176670		272322		-95652 ns

Note: ***, **, * mean significantly different at 1%, 5%, and 10% probability levels, respectively.
ns means not significantly different at 10% probability.
Figures in parantheses are percentages.

On the other hand, the coefficient of variation in total revenue of the SYGAP participants in Karawang (104 %) was significantly greater than that of the non-participating farmers (62 %). Higher variability in total revenue of the SYGAP participants could be attributed mainly to higher variability in their yields (C.V. = 91.5 % for participants and 62.3 % for non-participants). The variability in total revenue for both farm groups in this district could be explained mainly by the variability in yield rather than the variability in soybean price (C.V. = 16 % for SYGAP participants and 4 % for the non-participants).

Table 13. Coefficients of variation of total costs, total revenue, and net income, 120 sample farmers, Karawang, West Java and Jombang, East Java, 1991.

LOCATION	COEFFICIENT OF VARIATION (%)		
	Total Cost	Total Revenue	Net Income
KARAWANG, WEST JAVA			
Participants	42	104	211
Non-Participants	84	62	168
JOMBANG, EAST JAVA			
Participants	40	42	226
Non-Participants	63	44	90

The coefficients of variation in total revenue in Jombang of the SYGAP participants and the non-participants were almost the same, i.e., 42 and 44 percent, respectively owing to the fact that their coefficients of variation in yields were also close (C.V. = 40.4 % for the participants and 42.7 % for the non-participants). Variability in soybean yield contributed more to the variability in total revenue for both farm groups. An examination of the variability in net income reveals much higher coefficients of variation in net income of the SYGAP participants in Karawang and Jombang (211 % and 226 %, respectively) as compared with those of the non-SYGAP participants (168 % in Karawang and 226 % in Jombang) (Table 13). Hence it is more risky to adopt the SYGAP technologies as evidenced by the higher variability in net income of the SYGAP participants.

To supplement the coefficient of variation analysis, the variance decomposition analysis was also employed to determine the sources of variability in net income.

As shown in Table 14, the variances in net income of the SYGAP participants in both districts (107.9×10^{10} in Karawang and 16.6×10^{10} in Jombang) were larger than those of the non-participating farmers (36.4×10^{10} and 5.8×10^{10} in Karawang and Jombang, respectively). These figures indicate that the adoption of the SYGAP technologies is very risky as evident from the higher variability in net income of the SYGAP participants.

Variances of total revenues of both groups of farmers in both districts contributed most to the variabilities in net income than those of total costs and the covariances of total revenues and total costs.

In Karawang, the interaction between total revenue and total cost decreased the variability in net income of the SYGAP participants. Conversely, it increased the variability in net income of the non-participants.

Table 14. Variance decomposition of net incomes of soybean farmers in Karawang, West Java and Jombang, East Java, 1991.

DISTRICT/TYPE OF FARMER	V (I)	V (Y)	V(C)	2 Cov (Y,C)
KARAWANG				
Participants	107.9×10^{10}	110.6×10^{10}	4.8×10^{10}	-7.5×10^{10}
	(100.0)	(102.5)	(4.5)	(-7.0)
Non-participants	36.4×10^{10}	22.2×10^{10}	12.6×10^{10}	1.6×10^{10}
	(100.0)	(61.1)	(34.6)	(4.3)
JOMBANG				
Participants	16.6×10^{10}	10.7×10^{10}	4.8×10^{10}	1.1×10^{10}
	(100.0)	(64.4)	(28.8)	(6.8)
Non-participants	5.8×10^{10}	6.0×10^{10}	2.0×10^{10}	-2.2×10^{10}
	(100.0)	(103.7)	(33.9)	(-37.6)

Note : V (I) = variance in net income
V (Y) = variance in total revenue
V (C) = variance in total costs
Cov (Y,C) = covariance in total revenue and total costs
Figures in parantheses are percentage to variance in net income

In contrast, the interaction between total cost and total revenue reduced the variability in net income of the non-participants in Jombang, but it increased the variability in net income of the SYGAP participants.

CONCLUSION AND POLICY RECOMMENDATIONS

Conclusion

All the SYGAP participants in Karawang and Jombang used the recommended soybean varieties. Except for the recommended soybean varieties, not all of the 60 SYGAP participants in Karawang and Jombang adopted other recommended technologies (e.g., seeding rate, seed treatment, N, P and K fertilizer rates, frequency of spraying pesticides, and distance between drainage canals). Nevertheless, majority of them adopted the recommended technologies.

Findings of the study also revealed a radiation effect of the project. There were non-participants who partially adopted the recommended SYGAP technologies.

The potential or target soybean yields were not generally achieved by the SYGAP participants in both districts. This could be attributed to army worm infestation and the variation in the planting schedule of most farmers in Karawang. Thus, the yield-augmenting effect of the SYGAP technologies was masked by serious pest infestation in Karawang.

Mean net incomes received by the SYGAP participants and the non-participants in Karawang were not significantly different because mean gross income and total cost did not vary significantly between these two farm groups. Likewise, net income did not vary significantly between the SYGAP participants and non-participants in Jombang.

The adoption of the SYGAP technologies in both districts is very risky as evident from the higher variability in net income of the SYGAP participants as compared to that of the non-participants. The variance in total revenue of both groups of farmers in both districts contributed most to the variability in net income than the variance in total cost and the covariances of total revenue and total cost.

Policy Implication and Recommendations

Based on the foregoing findings of the study, the following are recommended :

(1). The government should continue encouraging the farmers to produce soybean in the study areas considering that this crop was found to be profitable to grow in both the SYGAP and non-SYGAP farms.

(2). The government should also accord top priority to providing funds for research aimed at developing soybean varieties that are resistant to pests and are drought tolerant. Unless pest resistant and drought tolerant soybean varieties are developed, it is not advisable to continue promoting the SYGAP technologies to farmers in less favorable environments (e.g., limited water supply) in the short run. It is, therefore, recommended that the SYGAP technologies with the new varieties (e.g., pest resistant and drought tolerant) should be promoted in less favorable environments in the long run.

(3). Irrigation development in Jombang would also improve the soybean productivity in this district in the long run. Moreover, the SYGAP technologies would have a more pronounced effect on soybean productivity. Considering that the yield-augmenting effect of fertilizer would be enhanced with assured water supply in the area.

(4). In the short run, it is imperative that the extension personnel should promote or introduce the SYGAP technologies only in areas with favorable environment (e.g., areas with assured water supply and good drainage) to maximize the yield potential of the technologies.

(5). In order to arrive at a more comprehensive measurement of the impact of the SYGAP technologies in the study areas, further studies should be conducted covering a longer period. The present study utilized only one season data (1991 dry season). Unfortunately, environmental condition during this period were abnormal.

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Appendix Package of technologies introduced under the SYGAP, Jombang, Wonogiri, and Karawang districts, Indonesia.

LOCATION	PACKAGE OF SOYBEAN TECHNOLOGIES
JOMBANG	
Variety	Wilis
Fertilizers	22.5 kg N + 23 kg P_2O_5 + 25 kg K_2O/ha applied at planting
Pest control	Seed treatment + 5 insecticide sprays (21, 35, 42, 50 and 60 DAS or days after seeding)
Plant spacing	40 cm x 15 cm, 2 plants/hill (45 kg/ha)
Drainage	Every 3 m
WONOGIRI	
Variety	Nengahan Genjah
Fertilizers	22.5 kg N + 23 kg P_2O_5 + 25 kg K_2O/ha applied at planting
Pest control	4 sprays (7, 21, 42 and 60 DAS)
Plant spacing	30 cm x 15 cm, 2 plants/hill (70 kg/ha)
Drainage	Every 3 m and deep enough
KARAWANG	
Variety	NS1 or 3034-II-12-13
Fertilizers	22.5 kg N + 34.5 kg P_2O_5 + 25 kg K_2O/ha applied at planting
Pest control	3 sprays (21, 42 and 60 DAS)
Plant spacing	40 cm x 10 cm, 2 plants/hill (60 kg/ha)
Drainage	Every 4 m

Source: ESCAP CGPRT (1992)